

MARGINAL COST ANALYSIS

DOCUMENTATION

June 1996

## **INTRODUCTION**

The results presented in the Marginal Cost Analysis (MCA) for BPA's wholesale rate proposal are based on analysis and computation of a substantial number of data. This information is presented in full in this document.

The documentation contains BPA's marginal costs from The Power Market Decision Analysis Model (PMDAM) for each of the 50 "games" run for the MCA in Section I, a technical discussion of the cluster analysis used in defining heavy and light load hours in Section II, data on the operation of some of BPA's existing capacity contracts in Section III, also used in defining heavy and light load hours, information from the Electric Power Research Institute on costs of combustion turbines used in estimating the marginal cost of demand in Section IV, BPA's forecast of natural gas prices for its final proposal in Section V, a detailed description of PMDAM in Section VI, the database of PMDAM inputs in Section VII, a report on PMDAM methodology in Section VIII, and a report on PMDAM by Karen Crowther, prepared for the California Public Utilities Commission, in Section IX.

**SECTION I**

**SECTION II**

## CLUSTER ANALYSIS

The cluster analysis grouped 168 marginal costs representing the hours of a typical week into 2 clusters. Each marginal cost fell into one and only one cluster.

Table 8 from the study (WP-96-FS-BPA-04) presents the cluster analysis. Table 9 gives the results. These tables are reprinted here. The hours of the week are ranked in descending order by marginal cost of energy in Table 8. Column A gives the day-type - Sunday, Weekday, or Saturday. Column B gives the hour of the day. Column C gives the marginal cost. If the day-type is "Weekday," then identical data appear for each of the five weekdays in Columns C through G.

Column H gives the pseudo F-statistic when the clusters are divided at the given row. The pseudo F-statistic is a measure of between-cluster variation divided by within-cluster variation. The mathematical definition of the Pseudo F statistic is:

$$\text{Pseudo F} = \frac{(\sum_{i=1}^n (l_i - \bar{l})^2 - \sum_{j=1}^g \sum_{i \in C_j} (l_i - \bar{l}_j)^2)}{(g - 1)}{\frac{\sum_{j=1}^g \sum_{i \in C_j} (l_i - \bar{l}_j)^2}{(n - g)}}$$

where

$\bar{I}_j$  = the mean marginal cost within the jth cluster

The numerator of this compound fraction (summations/(g-1) ) expresses the total variation among marginal costs relative to within cluster variation, adjusted for degrees of freedom. This also represents the between cluster variation, adjusted for degrees of freedom. The denominator (summations/(n-g) ) expresses the within cluster variation, adjusted for degrees of freedom.

The pseudo F-statistic reaches its maximum value of 772.534 in Row 49. All hours with marginal energy costs of 13.17 m/kwh or lower fall into the lower cluster; all hours with marginal energy costs of 13.26 m/kwh or higher fall into the upper cluster.

Table 9 shows the marginal energy cost for each hour of the week ordered chronologically, and it indicates which cluster the hour falls into. Column A gives the hour of the day. Columns B, D, and F give the marginal energy costs, and Columns C, E, and G show an “L” if the hour falls into the lower cluster and an “H” for the upper cluster.

**SECTION III**

### **A NOTE TO SECTION III**

This section provides about one month's worth of data on the delivery of return energy to BPA from PP&L and PGE under their capacity contracts with BPA to support the designation of Sunday as composed entirely of light load hours. The data are for September of 1995, in megawatt-hours for each hour.



**SECTION IV**

#### **A NOTE TO SECTION IV**

This section supports the data in Lines 47 and 48 of Table 3 of The Study. The values referred to there appear near the end of this section in a reproduction of a facsimile transmission from the Electric Power Research Institute. They are marked with an asterisk\*. The preceding pages contain a technical, economic discussion of combustion turbines. This discussion includes information on capacity factors for plants such as those whose costs appear in Table 3 of The Study on EPRI (not BPA) page numbers 8-85 and 8-86.

**SECTION V**

**SECTION VI**

**SECTION VII**

**SECTION VIII**

**SECTION IX**